



intersound

**PRV-1**  
**PARAMETRIC**  
**EQUALIZER-REVERB**

a **gulton** company

**OWNER'S MANUAL**

## GENERAL DESCRIPTION

INTERSOUND's parametric equalizer-reverb, the PRV-1, is a professional sound processing unit suitable for most applications requiring advanced sound control concepts. The PRV-1 is designed with sufficient headroom and interfacing flexibility to accommodate virtually every normal input and output requirement found in the industry today.

Ease of operation, useful features, and functional flexibility are emphasized in the design of the PRV-1. The control knobs most frequently used are large flanged knobs for easy access and readability. The LED ladder display permits easy and precise setting of the input level. The fully independent switching of reverb and line signals allows for great flexibility. The choice of balanced and unbalanced inputs and outputs ensures easy interfacing with other units. The steel chassis is designed for standard EIA 19" rack mounting.

The reverb section of the PRV-1 offers an exceptionally quiet, natural sound which compares favorably with much more expensive studio reverb systems. The parametric equalizer permits very flexible sound control. The PRV-1 is the result of over two years of experience in reverb design. Every feature has been carefully chosen to meet the demands of musicians and sound professionals. INTERSOUND is proud to bring you this outstanding product.

## THE INTERSOUND APPROACH TO REVERB

Natural reverberation, as it occurs in a large room environment, consists of many reflections so closely spaced that they are not perceived as discrete echoes. This gives a live room effect which is aurally pleasing. Many different methods are used to achieve the effect of natural reverberation without carrying around a full concert hall.

Large metal plate systems offer a very natural sounding solution to the problem, but their large size and high price restrict their applications to large studios. Smaller, torsional spring devices are used with some success, but they have some inherent problems; the simpler units tend to have a somewhat unnatural sound because the spring design does not reproduce enough different reflections to create the aural image of a reverberant room. The result is a noticeably springy quality of the sound. In addition, simpler units tend to be noisy. Most of these units, by the nature of their mechanical design, are susceptible to acoustic feedback when exposed to high sound pressure levels.

In an effort to reduce the springy quality, some manufacturers use limiter circuits to control the reverb signal. This is not particularly successful as the limiters only tend to prevent overdriving the spring on loud passages (something that proper level setting accomplishes without adding any unnaturalness to the sound). In addition, high quality limiters which function in an acceptable manner generally cost as much as an entire reverb unit!

INTERSOUND has solved many of the problems found in most spring reverb units. The basic sound of the spring is improved by using the more complex Accutronics Type 9 device with six different springs; this creates a highly complex pattern of reflections. The reverb sound quality is further improved by using a specially compensated drive circuit and extensive filter compensation in the reverb return circuit. With more accurate level adjustment possible through the use of the LED ladder display, no limiters or other control devices are needed. Special acoustic dampening of the spring assembly and a variable lo-cut filter make the PRV-1 virtually immune to acoustic feedback in high sound pressure level environments. The resulting reverb quality is astonishingly natural.

To provide even more control of the reverb, INTERSOUND added the most advanced type of equalization available today-- full parametric equalization. This allows the sound to be accurately tailored to the particular performance requirements. No other reverb offers so much equalization and performance.

The major improvements in spring reverb design found in the PRV-1 offer studio reverb quality at a fraction of the price with the added benefit of portability. This careful blending of quality features and superb performance makes the PRV-1 the best sounding rackmount spring reverb system available.

#### THE ADVANTAGES OF PARAMETRIC EQUALIZATION FOR REVERBS

Parametric equalization is used in the PRV-1 for some very good reasons. Equalization of some type for reverb devices is necessary for good performance. A review of the various types of equalization available will demonstrate the value of the parametric form.

Shelving type equalization is the familiar bass and treble control method. This type permits only general control of frequency response. It is a two band system with each band controlling half of the audio spectrum. As such, the resulting equalization tends to be very broad and general. For most applications, this form has very limited effectiveness.

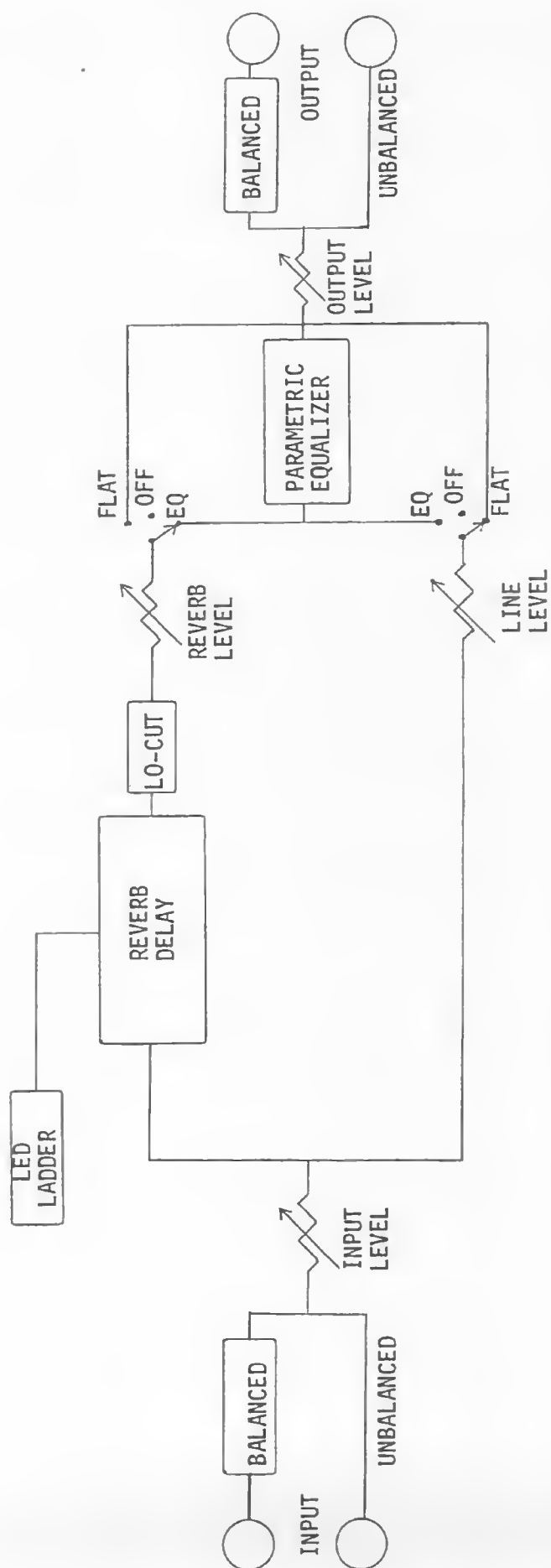
Graphic equalization is an improvement over the shelving type. In this method, the audio spectrum is divided into several different frequency bands with a separate boost/cut control for each band. The width and center frequency of each band are predetermined and fixed. The boost/cut controls are usually slider controls which present a visual or "graphic" presentation of the equalization settings. This method offers better equalization control than the shelving type, however, since the bandwidth may not be optimum and the frequencies not quite right, it still has limitations.

An improved form of graphic equalization is commonly called quasi or semi-parametric. This form adds the benefit of variable center frequency control of each band in the equalizer. While this method offers more control than the standard graphic control, the fixed bandwidths are often not optimum for all situations.

Full parametric equalization is the most useful and complete equalization available today. With parametric equalization, control of all three parameters is possible. The amount of boost or cut, the center frequency, and the bandwidth are all continuously variable over large control ranges. This permits a very wide variety of equalization effects to be created.

Recognizing the need for very flexible equalization in reverb units, INTERSOUND incorporates a two band parametric equalizer in the PRV-1. The equalizer uses fully symmetrical non-interacting bands of a low noise design. This allows optimum equalization of the reverb effect.

The parametric equalizer in the PRV-1 may be used to equalize the line (dry) signal, the reverb signal, or both. This is an important advantage of the PRV-1. A sound system using the PRV-1 not only gains a superb reverb capability, but also an extra two bands of parametric equalization. These may be used for broad band boost or cut or for extremely narrow band equalization for feedback control, hum and noise elimination, etc. The use of parametric equalization in the PRV-1 represents a major improvement in reverb design.



INTER SOUND PRV-1  
EQUALIZER-REVERB

## FUNCTIONAL DESCRIPTION

The PRV-1 is a straight line sound processing device. The line or dry signal is introduced through one of the INPUTS; proper levels are set; REVERB is added; LO-CUT filtering is adjusted; PARAMETRIC EQUALIZATION is introduced as desired; final OUTPUT LEVEL is set; and the processed signal is sent out of the unit through one of the OUTPUTS. This basic signal flow should be remembered when using the PRV-1.

The INPUTS of the PRV-1 permit the use of the unit with many different types of signal sources. Both BALANCED and UNBALANCED INPUTS are provided. The UNBALANCED INPUT uses a standard  $\frac{1}{4}$ " phone jack and will accept normal two conductor leads from sources with low level signals such as musical instruments or high level signals. The BALANCED INPUT has an electronic active balancing circuit and a D3F connector for use with balanced sources. Again, either low level or high level signals may be used.

The proper input level is easy to set using the INPUT GAIN CONTROL and the LED LADDER DISPLAY. The LED LADDER DISPLAY has peak hold time with slow decay; this design makes the display easy to read.

After the input section, the signal may be routed through the reverb section. The REVERB SELECTOR SWITCH is a three position switch which selects REVERB OFF, REVERB ON & FLAT, or REVERB ON with EQ. The level of the reverb is set with the REVERB LEVEL CONTROL. When using both reverb and line signals together, this control serves as one of the two controls that will mix the signals together. When only reverb is used, this control should be set to the mid position and not used as a level control.

The LO-CUT FILTER serves as a useful control of the low frequency response of the reverb. The variable frequency control selects the low frequency rolloff point thereby changing the sonic response. This is very convenient in removing certain signals which may muddy the reverb sound.

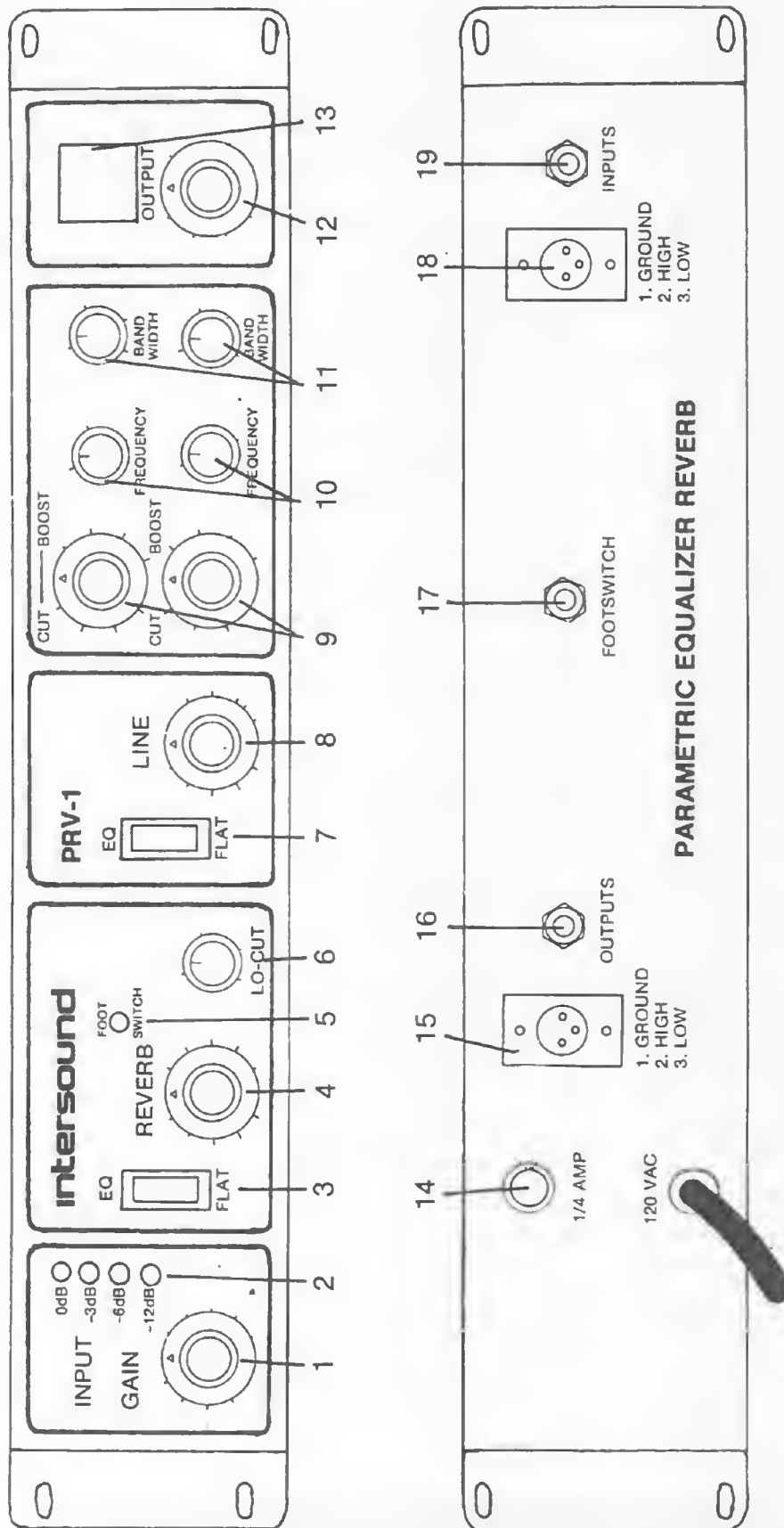
A FOOTSWITCH JACK on the rear panel permits the use of any standard footswitch to control the reverb from a remote position. When the reverb is selected on and a footswitch is plugged into the rear panel jack, the front panel FOOTSWITCH LED will indicate when the reverb is on.

NOTE: THE FOOTSWITCH LED ONLY INDICATES THE STATUS OF THE FOOTSWITCH CONTROL. WHEN THE REVERB SELECTOR SWITCH IS ON AND A FOOTSWITCH IS PLUGGED IN, THE RESULTING ON AND OFF ACTION OF THE FOOTSWITCH LED GIVES A VISUAL STATUS OF THE REVERB SIGNAL. IF NO FOOTSWITCH IS PLUGGED IN, THE FOOTSWITCH LED IS ON AT ALL TIMES AND CANNOT BE USED AS AN INDICATION OF THE PRESENCE OF REVERB SIGNAL.

The line signal may be selected in a similar manner to the reverb signal. The LINE SELECTOR SWITCH will select LINE OFF, LINE ON & FLAT, or LINE ON with EQ. There is no footswitch provision for the line signal. The level of the line signal is set with the LINE LEVEL CONTROL. When using both reverb and line signals together, this control is used in conjunction with the REVERB LEVEL CONTROL to mix the signals together. When only the line signal is used, the LINE LEVEL CONTROL should be set to the mid position and not used as a level control.

The two band PARAMETRIC EQUALIZER provides full range equalization for the reverb, the line, or both signals. Each band has a BOOST/CUT CONTROL, a FREQUENCY CONTROL, and a BANDWIDTH CONTROL. Very precise control of the tonal response is possible with this equalization. The two bands are also overlapped to facilitate frequency selections over a wide range.

The processed signal receives its final level adjustment from the OUTPUT LEVEL CONTROL. The BALANCED and UNBALANCED OUTPUTS permit the use of the PRV-1 with many different down-line devices. The BALANCED OUTPUT uses an electronic active balancing circuit and a D3M connector for feeding balanced lines. The UNBALANCED OUTPUT uses a standard  $\frac{1}{4}$ " phone jack for feeding two conductor leads. Both outputs may be used simultaneously.



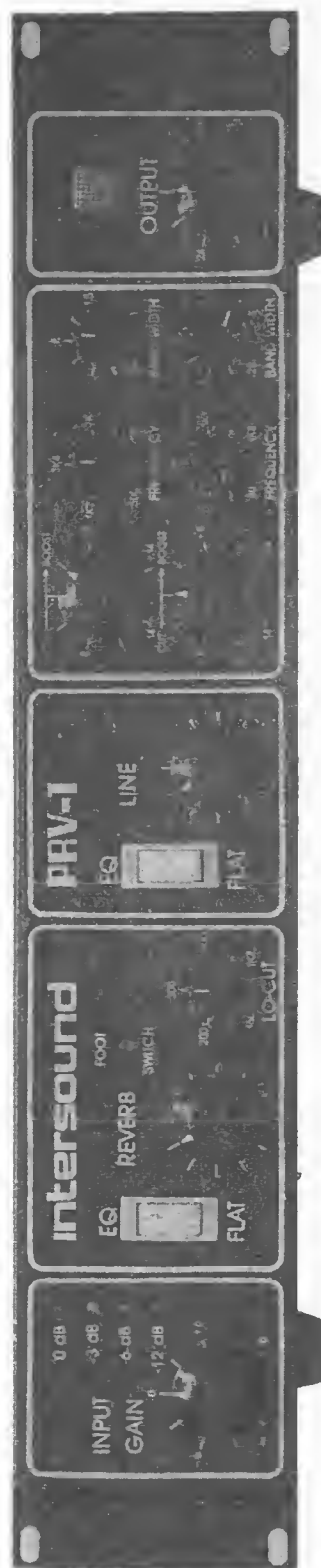
## PRV-1 CONTROLS & CONNECTIONS



## PRV-1 CONTROLS & CONNECTIONS

Before using the PRV-1, familiarize yourself with the various controls, connections, and their functions. This will give you a better overall understanding of the PRV-1 and help you to master the use of the unit. The use of each control will be discussed in the next section.

1. **INPUT GAIN CONTROL** — Sets the proper input level for optimum signal/noise ratio and prevention of clipping.
2. **LED LADDER DISPLAY** — Has increased hold time for an accurate easy-to-read display of the reverb drive level.
3. **REVERB SELECTOR SWITCH** — Controls the selection of REVERB OFF, REVERB ON & FLAT, or REVERB ON with EQ.
4. **REVERB LEVEL CONTROL** — Adjusts the level of the reverb return signal.
5. **FOOTSWITCH LED** — Indicates when the footswitch is on. This LED is useful when controlling the reverb from a remote location with a footswitch.
6. **LO-CUT FILTER CONTROL** — Selects the rolloff frequency of the lo-cut filter within the range of 150Hz to 1K2Hz.
7. **LINE SELECTOR SWITCH** — Controls the selection of LINE OFF, LINE ON & FLAT, or LINE ON with EQ.
8. **LINE LEVEL CONTROL** — Adjusts the level of the line signal.
9. **BOOST/CUT CONTROLS** — Select the amount of equalization boost or cut on each band.
10. **FREQUENCY CONTROLS** — Adjust the center frequency of each equalization band. The frequency is variable over its full range. The markings for frequencies over 1KHz are stated in an easy-to-read format — 1.8KHz is 1K8.
11. **BANDWIDTH CONTROLS** — Select the width of each band of equalization.
12. **OUTPUT LEVEL CONTROL** — Sets the final output level for proper matching of the output to other equipment.
13. **POWER SWITCH** — An illuminated push ON/push OFF switch controls power to the unit.
14. **FUSE HOLDER** — If needed, replace fuse with the same type ¼ amp, fastblow.
15. **BALANCED OUTPUT** — Has an active balancing circuit and a D3M connector.
16. **UNBALANCED OUTPUT** — A standard ¼" phone jack is provided for two conductor lines.
17. **FOOTSWITCH JACK** — A standard ¼" phone jack is provided for the use of an external footswitch.
18. **BALANCED INPUT** — A D3F connector with active balancing circuit is provided.
19. **UNBALANCED INPUT** — A standard ¼" phone jack is provided for two conductor lines.



PRV-1 FRONT



PRV-1 REAR

## PRV-1 SETUP PROCEDURES

The PRV-1 is designed for freestanding use or unsupported rack mounting. For rack mount installation, it may be necessary to remove the rubber feet from the bottom of the unit. It is recommended that the feet and screws be placed in a small bag and taped to the rear of the chassis for future use in freestanding applications.

The power cord should be plugged into a standard power source with a nominal rating of 95-120VAC and 50-60Hz. (EXPORT versions using 210-250VAC are clearly identified on the rear panel.) PLEASE NOTE: Hum problems may occur when several pieces of equipment are used together. If several units have three wire AC cords, the hum may be caused by a ground loop. The hum is not the fault of any individual unit; it is caused by the system interconnections. To eliminate this problem, use a three prong adapter to lift the neutral (ground) connection on one or more of the units. A three prong adapter may be purchased at most hardware or electrical supply stores. UNDER NO CIRCUMSTANCES SHOULD YOU USE THREE PRONG ADAPTERS ON EVERY PIECE OF EQUIPMENT IN THE SYSTEM! For your protection, at least one of the units should remain connected in the normal fashion--that is with the ground connected.

An additional source of hum may be encountered if the PRV-1 is mounted very close to a large power supply transformer such as found in power amplifiers. Although the PRV-1 has an all steel chassis for shielding, the reverb springs may allow some hum from the transformer field to enter the signal path. It is recommended that the PRV-1 be moved a few inches away from the hum source in this case.

The use of worn or inferior cables will also permit hum to be introduced into the signal path. INTERSOUND recommends the use of high quality cables throughout the system. All phone plug tips should be diamond shaped for positive locking in the jacks. Round ball shaped tips are not recommended. Three pin connectors should be of high quality and checked carefully for correct connections. Always keep cable lengths to a minimum. These simple precautions will prevent many frustrating problems.

Check the input and output specifications of the PRV-1 and of the other units in the system. The comparison of specifications will generally indicate the compatibility of the devices and indicate which input and output terminals should be used. The local INTERSOUND dealer or the factory can provide additional assistance if there are any questions.

With these thoughts in mind, connect the PRV-1 to the signal source. If using the PRV-1 in the effects loop of a studio or sound reinforcement system mixing board, connect the ECHO or TO jack of the board to the INPUT of the PRV-1. The use of the BALANCED or UNBALANCED INPUT will depend on the characteristics of the source. If a choice is available, always use the BALANCED INPUT for best performance. When used in live stage component instrument systems, the source may be either the instrument itself, or the effects send/output of a control preamplifier. The PRV-1 may be patched into any system as an in-series down line device as well as by the above methods.

Complete the connection of the PRV-1 by patching the appropriate OUTPUT to the RECEIVE or INPUT of the next unit. In the case of effects loops on mixing boards or preamplifiers, this would normally be identified as an ECHO RECEIVE or FROM ECHO jack on the unit. In most down line applications, the OUTPUT of the PRV-1 would connect to an INPUT on the receiving unit.

If a footswitch is used, choose any standard guitar type footswitch of the push ON/push OFF variety. IMPORTANT NOTE: FOR CORRECT OPERATION OF THE REVERB BY USE OF THE FOOTSWITCH, THE REVERB SELECTOR SWITCH MUST BE IN ONE OF THE TWO REVERB ON POSITIONS AND THE FOOTSWITCH MUST BE PLUGGED IN. THE FOOTSWITCH LED WILL ONLY INDICATE REVERB ON OR OFF IF THE ABOVE CONDITIONS ARE MET. IF A FOOTSWITCH IS NOT PLUGGED IN, THE FOOTSWITCH LED WILL REMAIN ON AT ALL TIMES REGARDLESS OF THE REVERB STATUS.

#### NORMAL OPERATING PROCEDURES

After completing the hookup, make a final check of all connections and turn on the power. It is recommended that the power amplifier be the last unit turned on. As simple as it may sound, be sure that the power is on for ALL units in the system.

The first time you use the PRV-1, use the following control settings as a starting point:

- A. INPUT GAIN- Full counterclockwise ( $-\infty$ )
- B. REVERB SELECTOR SWITCH- EQ
- C. REVERB LEVEL CONTROL- 10 o'clock position
- D. LO-CUT FILTER- 150Hz
- E. LINE SELECTOR SWITCH- FLAT (OFF when using the PRV-1 in mixing board effects loops)

- F. LINE LEVEL CONTROL- 12 o'clock position
- G. BOOST/CUT- (BOTH BANDS)- 12 o'clock position
- H. FREQUENCY- (BOTH BANDS)- Full counterclockwise
- I. BANDWIDTH- (BOTH BANDS)- 12 o'clock position--(.8)
- J. OUTPUT- 12 o'clock position

Introduce some program material through the system, slowly increasing the INPUT GAIN until the program material is heard. You should hear both line and reverb signals if using the PRV-1 in a series hookup. On a mixer effects loop hookup, the reverb signal will be present at the return on the board. Adjust the INPUT GAIN until the LED LADDER DISPLAY is showing both green LEDs on most of the time (-6dB) and the yellow LED on some of the time. An occasional illumination of the red LED will probably not be harmful to the sound quality. It is important to operate the input signal level as high as possible without causing clipping; this will ensure the optimum signal-to-noise ratio.

Increase and decrease the REVERB LEVEL CONTROL and note the effect it has on the signal. If the LINE SELECTOR SWITCH is in the FLAT position, changing the REVERB LEVEL CONTROL setting will alter the relative amount of reverb being mixed with the dry or line signal. If the LINE SELECTOR SWITCH is OFF, changing the REVERB LEVEL CONTROL setting will only change the volume level of the signal.

Slowly increase the frequency setting of the LO-CUT FILTER. Notice the change in the reverb sound as the filter cuts out more and more of the bass frequencies. This control is very useful in contouring the reverb response for the most effective sound. In live stage environments or wherever high sound pressure levels are experienced, this filter will help to eliminate acoustic feedback as well as contour the sound. The actual setting for this control will depend on the type of program material, the location of the PRV-1, and personal preference.

Switch the REVERB SELECTOR SWITCH to the OFF position. This removes all reverb from the system. If the LINE SELECTOR SWITCH is also OFF, all signal flow stops. The sound of the reverb with the REVERB SELECTOR SWITCH in the FLAT position will be the same as heard in the EQ position. The reason is that the EQ stage is still set flat. When equalization is added, the FLAT position of the REVERB SELECTOR SWITCH is useful to compare the effect of the equalization with the flat signal. This will be observed shortly.

In a similar manner, familiarize yourself with the LINE SELECTOR SWITCH and the LINE LEVEL CONTROL. Notice that these controls function

in the same way as the reverb controls. The only functional difference is that the LQ-CUT FILTER operates only on the reverb signal and not on the line signal.

Return all controls to their original position. Set the proper input level. In the equalization stage, turn the BOOST/CUT CONTROL of the upper EQ band to maximum boost (+14dB). Notice the rather drastic increase in the sound level of frequencies around 500Hz. Sweep the FREQUENCY CONTROL over its entire range. The boosted frequencies will shift upward as you increase the center frequency of the band. Turn the BANDWIDTH CONTROL through its range and notice the audible effect. At very narrow bandwidths, (.25), the EQ band can function as a notch filter by using large amounts of cut. Large bandwidths, (3), allow the EQ band to be used as a wide band filter for broad equalization.

The lower equalization band functions in a similar manner. The frequency range from 500Hz to 1K8Hz is common to both bands. This overlap allows either band to be used for mid-range equalization.

Try different equalization settings on both the reverb signal and the line signal. The added versatility of the full parametric equalization permits a wide contrast of sonic possibilities. Careful adjustment of the equalization on the reverb will result in a very pleasing reverberation effect.

The few minutes spent reviewing the controls of the PRV-1 will make the features and functions of the unit easy to understand. Should the preferred settings vary from those stated herein, do not be concerned. This is perfectly acceptable as long as the LED LADDER DISPLAY indicates that the proper level is set. Too low a level may require excessive gain at the final output stage with resulting poor signal-to-noise ratio. Too high a level may result in distortion or overdriving of the reverb. Setting the proper level will ensure good performance.

### PRV-1 APPLICATIONS

As previously noted, the PRV-1 is designed with a wide range of flexibility. Because of this, there are many applications for the PRV-1. Here are a few.

#### EXTERNAL EFFECT FOR STUDIO OR LIVE MIXING BOARDS

A very popular application for the PRV-1 is in the effects loop of a studio or live concert sound mixing board. Although many mixing

boards have a built-in reverb system, the quality of the reverb is often less than desirable. Some mixers have one or more external effects loops but no built-in reverb system. Since reverb is one of the basic tools of the sound engineer, a sophisticated reverb system is important. The PRV-1 is well suited for use with mixers. The extremely quiet performance, parametric equalization, and excellent sound meet the requirements for quality in demanding applications. The remote footswitching capability is particularly useful in live mixing situations. When used in the effects loop of a mixing board, the line signal should not be used and the reverb should normally be set to the EQ position.

#### INSTRUMENT AMPLIFICATION SYSTEMS

With the growing shift to separate component amplification systems for stage musicians, the demand for improved quality extends to effects as well as basic amplification. The special features of the PRV-1 make it particularly well suited for stage systems. The special acoustic isolation, lo-cut filter, and full parametric equalization offer the stage musician control, feedback protection, and full range reverberation in a roadworthy system. Keyboard players and guitarists alike will appreciate the natural reverb characteristics of the PRV-1. The PRV-1 represents a major improvement over reverb systems presently incorporated in stage musical equipment. A typical stage installation for the PRV-1 is as a series unit in a component system or as an external effect in the effects loop of an instrument preamplifier such as the IVP, INTERSOUND's Instrument Voicing Preamplifier.

#### SIGNAL PROCESSING IN STUDIO MIXDOWNS

The ability of the PRV-1 to function as a separate equalizer offers yet another studio application. During initial track laydown, the PRV-1 can be patched in as an extra parametric equalizer for difficult sessions when all of the studio equalizers are already assigned and more equalization is needed. Then, during the mixdown, the same PRV-1 can be switched to reverb to add just the right amount of ambience. This dual purpose capability is unique to the PRV-1 and an added value to the owner.

#### CHURCH AND INSTITUTIONAL SOUND REINFORCEMENT SYSTEMS

The importance of quality sound systems in churches and schools today cannot be overlooked. As their systems improve, the need for natural sounding reverb with professional performance is even more clear. The PRV-1 is perfect for these applications. The natural sounding ambience provided can compensate for the architectural acoustics of many modern churches and auditoriums. The added benefits and reasonable price of the PRV-1 make it a valuable addition to many sound systems used by schools, theatrical companies, dance companies, and others.

## SPECIFICATIONS

INPUTS: ½" PHONE JACK- unbalanced, (25K Ohm)  
D3F CONNECTOR- active balanced, (40K Ohm)

INPUT LEVELS: UNBALANCED

Nominal: .800 Vrms (0dBV)  
Minimum: 100 mVrms (-16dBV)  
Maximum: 8 Vrms (+20dBV)

BALANCED

Nominal: .800 Vrms (0dBV)  
Minimum: 100 mVrms (-16dBV)  
Maximum: 8 Vrms (+20dBV)

REVERB STAGE: Compensated Accutronics Type 9 delay with acoustic isolation

DECAY TIME: 3.0 seconds

SIGNAL/NOISE RATIO: 68dB A weighted

DRY STAGE: (Reverb OFF)

FREQUENCY RESPONSE: 20Hz-20KHz +1dB

SIGNAL/NOISE RATIO: at 0dB (.775 Vrms) 90dB A weighted

LO-CUT: 12dB/octave bandpass filter

TURNOVER FREQUENCY: variable 150Hz-1K2Hz

EQUALIZATION STAGE: Full parametric type

Two independent bands:

Band 1: frequency range 80Hz-1K8Hz

Band 2: frequency range 500Hz-12KHz

Boost/Cut: +14dB each band

Bandwidth range: 0.25-3.00 octaves each band

ROUTING CONTROL:

LINE: EQ, OFF, FLAT

REVERB: EQ, OFF, FLAT

CONTROLS:

Input level, line selector, reverb selector, lo-cut, reverb level,  
line level, Band 1 boost/cut, frequency, bandwidth, Band 2 boost/cut,  
frequency, bandwidth, output level

OVERALL GAIN:

Nominal: 0dB (EQ flat and nominal operating levels)

Maximum: +26dB

OUTPUTS: ½" PHONE JACK- unbalanced into 1K Ohms or higher

D3M CONNECTOR- active balanced into 600 Ohms or higher

OUTPUT LEVELS: UNBALANCED

Nominal: .800 Vrms (0dBV) into 1K Ohms

Maximum: 8 Vrms (+20dBV) into 1K Ohms

BALANCED:

Nominal: 1.0 Vrms (+2dBm) into 600 Ohms

Maximum: 9.0 Vrms (22dBm) into 600 Ohms

POWER SUPPLY: Regulated, dual tracking, current limited, fused

100-130VAC, 50-60Hz (210-250VAC optional)

MOUNTING: Standard 19" EIA rackmount

DIMENSIONS: (H-W-D) 3½X19X11 inches

WEIGHT: 13 lbs. (15 lbs. shipping)

CHASSIS: 16 gauge cold rolled steel

SEMICONDUCTOR COMPLEMENT: 16 ICs, 16 transistors, 2 FETs, 13 diodes, 1 zener diode